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ABSTRACT

The present study was designed to replicate findings concerning the effect of question position on retention of practiced and non-practiced information and to further evaluate the robustness of the mathemagenic concept by comparing the effectiveness of subject-generated pictures as adjunct aids with written multiple choice questions. The subjects were 63 undergraduate students from three introductory educational psychology courses. The following hypotheses were tested: performance on practiced questions will be significantly higher than on non-practiced questions; where adjunct aids appear after textual passages, performance will be significantly higher than where they appear before those passages; those groups with pictorial adjunct aids will perform at least as well or better than those groups with written adjunct aids; and all experimental groups will significantly outperform the control group on practiced questions. Of the four hypotheses tested, the first three were fully supported and the fourth was partially supported. (Author/RB)

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A COMPARISON OF PICTORIAL AND WRITTEN ADJUNCT AIDS IN LEARNING FROM TEXT

Jack Snowman and Donald J. Cunningham

Rothkopf (1966, 1967, 1970), Frase (1968, 1970) and others (e.g., Keller & Cunningham, 1972; Cunningham & Keller, 1972) have shown that the insertion of test-like questions in textual passages can alter reading behavior by modifying the stimulus value of the text. Generally, these studies have shown that the insertion of questions in a passage results in increased retention of material directly covered by these questions (practiced retention) as compared to unquestioned controls. Additionally, questions inserted just after a specified passage aid retention of material not directly covered by these adjunct questions (non-practiced retention) as compared to questions before and (perhaps) as compared to unquestioned controls, although this latter point is currently a point of controversy (Ladas, 1973). Rothkopf has proposed that data such as these are best interpreted under a ruberic he labels "mathemagenic behaviors," the study of behavior which influences learning.

Since Rothkopf's initial work in the area, a number of variables such as question frequency, question type, instructional set, etc. have been examined in order to test the robustness of the phenomena (see Frase, 1970 for a review). The theoretical bases and methodological techniques used by researchers in this area have come under increasing criticism recently (e.g., Carver, 1972 Ladas, 1973) but general agreement does seem to have been attained concerning the importance of the behaviors under investigation and the potential of investigations in this area to offer insights into the instructional process.

The use of pictorial materials within a mathemagenic framework has not as yet been attempted possibly because previous research seeking

enhanced retention of connected discourse as a function of pictorial stimuli has been inconclusive (see Carroll, 1971). However there is evidence to suggest that when pictures require the same type of information processing as their semantic analogue they may facilitate retention (Matz & Rohwer, 1971). Levin (1973), in failing to replicate the results of Matz and Rohwer (1971), speculated that his pictorial materials may have been less than ideal representations of the stories. Additionally, he felt that some kind of linguistic accompaniment to the pictorial materials was necessary noting the presence of this feature in the Matz and Rohwer (1971) study.

The mathemagenic framework appeared to lend itself easily to these considerations. Pictures could serve the same purpose as questions - as devices to induce rehearsal or memory search - and could be employed within a basically linguistic context.

The present study was designed, then, to replicate previous findings concerning the effect of question position on retention of practiced and non-practiced information and to further evaluate the robustness of the mathemagenic concept by comparing the effectiveness of subject generated pictures as adjunct aids with written multiple choice questions. It was decided to have the Ss generate their own pictures rather than have E supply them for two reasons. First, it more closely paralleled the treatments where questions were used in that S had to make an overt response. Second, as Anderson (1967) has pointed out, learning is facilitated when overt, constructed responses are made provided that the response is relevant to what is to be learned.

The following hypotheses were proposed: (1) Performance on practiced questions will be significantly higher than on non-practiced questions. (2) Where adjunct aids appear after a textual passage, performance will be

significantly higher than where they appear before those passages. (3) Those groups with pictorial adjunct aids will perform at least as well or better than those groups with written adjunct aids. (4) All experimental groups will significantly outperform the control group on practiced questions.

In addition to the groups receiving either written or pictorial adjunct aids there were two additional groups whose treatment included both types of adjunct aids, one with the adjunct aids before, one with them after the relevant text. The decision to include these two groups was made in order to evaluate the possibility of an additivity of adjunct aids. Due to the exploratory nature of this treatment no hypotheses were advanced concerning the performence of subjects in these groups.

METHOD

Materials

A 2,189 word passage describing a fictitious tribe in a fictitious country in east central Africa was used. The material was assembled in booklets of 20 pages. Each page was $8\frac{1}{2}$ x $5\frac{1}{2}$ inches and contained two paragraphs of text. Each paragraph contributed one four alternative multiple-choice question to the criterion test which required the recall of specific factual information from that paragraph. The questions were constructed so as not to overlap in content. Item arrangement on the test was random. Each subject, except the controls, received a booklet that had wither written adjunct questions, a direction to sketch a picture, or both (the direction to draw occuring first on one page and the question following on the next page). The direction to sketch a picture was simply a restatement or the corresponding question into imperative form (without the alternative answers, of course). Within each of these three types the

adjunct aid (question, instruction to draw, or both) appeared either immediately before or after each page of text. Including the control group this resulted in seven versions of the booklet. These were designated as QB (question before, QA (question after), PB (picture before), PA (picture after), BB (both before), BA (both after), and C (Control).

Those questions or directions to draw which were interspersed throughout the text were randomly selected with the restriction that of the twenty paragraphs from which they were derived, ten were to be drawn from the first paragraph and ten from the second. These questions were designated as practiced (P) items. The remaining twenty automatically became the non-practiced (NP) items.

The criterion test was validated on a separate sample from the same population. Kuder-Richardson reliability was .85 and Spearmen-Brown reliability was .81.

Subjects

The Ss were sixty-three undergraduate students from three introductory educational psychology courses at Indiana University. Subjects were run in their classes with assignment to treatment randomized within class and with the restriction of equal cell sizes.

Design and Procedures

The design of the experiment constituted a 3 x 2 x 2 factorial with repeated measures on the last factor. Type of adjunct aid (question, picture, or both) and position (before or after) were between subject factors. Scales (practiced and non-practiced) was the within subjects factor. Before beginning, all Ss were instructed to carefully read the directions attached to their booklet explaining the nature of the task. They were allowed to work through the booklet at their own rate but were

not allowed to review. Subjects were also requested to record the time at which they started and finished. Immediately after completing the booklet the criterion test was administered.

RESULTS

The initial analysis was carried out by means of two separate analyses of variance, one without the control group and one with the control group. The analysis without the control group constituted a 3 x 2 x 2 factorial as outlined in the design section. As Table 1 indicates, no differences were observed between treatment groups with respect to type of adjunct aid ($F<1$, $df=2/48$). The expected advantage of having the adjunct aid appear immediately after the textual passage as opposed to before, was observed ($F=4.92$, $df=1/48$, $p<.05$). The advantage of the P over the NP items, which has also been previously demonstrated, was reliably replicated ($F=129.57$, $df=1/48$, $p<.001$). The significant Position x Scales interaction ($F=7.63$, $df=1/48$, $p<.01$) that appears in Figure 1 was not unexpected as it has appeared in previous research of similar design (Keller & Cunningham, 1972). Inspection of this interaction reveals no position advantage with P items but adjunct aids appearing immediately after text segments produced increased retention of NP items.

The analysis which included the control group constituted a 7 x 2 factorial. The only additional finding of interest in this analysis was a significant Types x Scales interaction ($F=7.46$, $df=6/56$, $p<.05$) which has been depicted as a histogram in Figure 2 for purposes of clarity. This interaction shows that with P items the six treatment groups retained more than the control group whereas with NP items only those who received the adjunct aid after the reading passage retained more than the control group. However, a Dunnett's test, with P items as the dependent measure,

revealed that only the QA group significantly outperformed the control group ($p < .05$). With NP items as the dependent measure the Dunnett's test revealed no significant differences between any of the experimental groups and the control group. Thus, while the data are in the predicted direction, the predicted differences do not achieve conventional levels of significance.

Since half of the P and NP items were derived from the first paragraph of text while the remining half were derived from the second paragraph, it was possible to analyze the effect of this location factor on recall. Since this analysis had produced some interesting results in earlier research (e.g., Cunningham & Keller, 1972) the data were reanalyzed by means of a 3 (question, picture, both) x 2 (before, after) x 2 (practiced, non-practiced) x 2 (first paragraph, second paragraph) repeated measures analysis of variance. The first two factors were between Ss while the latter two were the repeated measures. An inspection of the significant Scales x Paragraph Location interaction ($F=22.66$, $df=1.48$, $p < .001$) revealed that P items were recalled better than NP items regardless of their location in the text although the advantage was greatest when they were derived from the first paragraph (Figure 3). A significant Position x Paragraph Location interaction ($F=6.48$, $df=1/48$, $p < .05$) revealed that recall for criterion questions (both practiced and non-practiced) derived from the second paragraph was higher for those who received the adjunct aid after the relevant passage over those who received it before. There was no such difference when the criterion question was derived from the first paragraph (Figure 4).

Since the Position x Paragraph Location and Scales x Paragraph Location interactions were significant but the second order Position x Scales x Location interaction was not, it was decided to analyze this

latter interaction separately. Specifically, it was thought that the second order interaction may have turned up non-significant because the Position x Paragraph Location interaction was significant with P items and non-significant with NP items. Consequently, two additional three factor ANOVA's were run, one with NP items, one with P items as the dependent measure.

The results of these two additional analyses were precisely in agreement with the above hypothesis (Figure 5). With P items as the dependent measure, the Position x Paragraph Location interaction was highly significant ($F=9.98$, $df=1/48$, $p<.005$) but was non-significant with NP items as the dependent measure ($F<1$, $df=1/48$). An additional finding from the analysis using P items as the dependent measure was a significant Adjunct Aid Type x Paragraph Location interaction ($F=3.94$, $df=2/48$, $p<.05$). Shown in Figure 6, it indicates that pictures are least effective as adjunct aids when the P item has been derived from the first paragraph and most effective when derived from the second paragraph.

Finally, the time to completion data that was collected from each S was subjected to a one way ANOVA and Dunnett's test. Only those Ss who were instructed to produce a drawing after each section of text took significantly more time than the control group ($p<.05$).

DISCUSSION

Of the four hypotheses which were initially proposed, three were fully supported. The superiority of adjunct aids appearing after a textual passage as opposed to before and the superiority of P items over NP items were both demonstrated. These phenomena appear to be rather robust as they have been repeatedly obtained with various types of reading material and different sets of instructions. Additionally, these effects have now been extended to include reader generated pictures. As Table 1

and Figure 2 revealy pictures were as effective as questions in facilitating retention.

The fourth hypothesis was partially supported since only the QA group significantly outperformed the control group on P items. This hypothesis was based on the following rationale: Ss who received the adjunct aid before the relevant portions of text would be forced to guess at the correct response and would probably guess wrong. However, they would then be cued in to the portion of text associated with the adjunct aid and upon encountering the item again in the criterion test could more easily retrieve the appropriate material from memory to correctly answer the question. Although it is possible that being forced to offer an incorrect response interfered with Ss ability to later retrieve the appropriate information, the QB and PB groups narrowly missed exceeding the critical value for the Dunnett's test. On the other hand, Ss who received the adjunct aid after text were expected to outperform the control group due to the review function of the adjunct aid. That is, it was assumed that the adjunct aid would force S to review what he had just read in order to correctly respond to the adjunct aid. As was indicated, only the QA group significantly outperformed the control. Perhaps these effects will increase over a longer and more difficult reading passage.

The inclusion of two groups that received both a direction to draw and a multiple choice question was made to determine if the two adjunct aids would exhibit additive effects. Although this turned out not to be the case, a slight ceiling effect in the criterion scores was apparent indicating the material was not sufficiently difficult to reveal any additional variance that may have been present. A replication of this study with either more difficult material or younger Ss is needed before

any definitive statements can be made regarding the additivity of adjunct aids. A replication may also further clarify the present findings comparing pictorial aids with written aids. Given a reading passage that could potentially produce more variance, it would be interesting to see if pictures produce a stronger mathemagenic effect or if they act at the same level as questions as they did in the present study.

If it can be assumed that presenting adjunct aids before text serves an arousal function as the work of Berlyne (1965) suggests, then the significant Position x Scales interaction indicates that, with the type of adjunct aids used in this study, arousing a reader's curiosity before reading a textual passage is an effective strategy for inducing him to learn the material that bears directly on the question or the direction to draw but is less effective regarding information in the passage that is not related or is incidental to the adjunct aid. Use of adjunct aids in this fashion enccurages the reader to employ a very narrow and specific information processing strategy. This is not necessarily detrimental but needs to be considered in conjunction with instructional objectives.

The analysis of the question location data was rather interesting and will be discussed in terms of an information search and processing model originally posited by Cunningham and Keller (1972). Briefly, the current version of this model states that where adjunct aids precede text segments it is assumed Ss enter the aid into memory and initiate rehearsal so that it will be available in memory when S turns to the text and begins reading. Reading is viewed as an information search activity where the reader scans for information which will confirm or disconfirm his response to the adjunct aid. Material not relevant to the search will receive less attention and presumably less processing.

In treatments where adjunct aids follow text segments S is assumed to read and incorporate as much of the material a he can so that it will be available in memory when the adjunct aid is encountered. S could then retrieve the appropriate information to meet the demands of the adjunct aid.

This model leads to several expectations for both P and NP retention. Where adjunct aids precede text, P items derived from the first paragraph should be better recalled than P items derived from the second paragraph due to the decreased amount of intervening material between the aid and knowledge of correct results. Conversely, where adjunct aids follow text, P items derived from the first paragraph should be less well recalled than P items derived from the second paragraph for the same reason. This implies a disordinal interaction between adjunct aid position and location. As Figure 5 shows, this effect was obtained.

The data for NP retention agree with previous research (Cunningham and Keller, 1972) with the exception that NP retention is not higher overall when it appears before than when it appears after P content. It had been assumed that when Ss in the QB, PB, and BB groups encounter P content in the first paragraph, they would not be likely to continue reading carefully the NP content, hence recall it less well. That this did not occur may indicate only that the Ss found the reading materials interesting and did not narrow their attention to the P content. Informal student comments about the reading materials has been generally very favorable which lends some credence to this reasoning.

Taken as a whole these data extend the potential range of adjunct aid from entirely verbal, to a combination of visual and verbal. Both types seem to operate comparably and both types seem consistent with the model of prose learning proposed by Cunningham and Keller (1972).

Unfortunately, there have been few attempts on the part of those interested in prose learning to explore the implications of jointly employing both types of stimuli so that even tentative generalizations cannot yet be drawn. One extension currently being pursued is the effect of question and imagery adjunct aids on parallel concrete and abstract passages with adolescents. It is hoped that these efforts will stimulate other researchers to consider the use of non-verbal stimuli or processes within a prose learning setting.

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TABLE I

Mean Performance for Main Effects of Type, Position and Scales for Analysis without Control Group

	Type of Adjunct Aid			Position *		Scales**	
	Question	Picture	Both	Before	After	Practiced	Non Practiced
$\bar{x}$	15.72	15.61	15.72	15.07	16.29	17.59	13.77

*$p < .05$
**$p < .001$

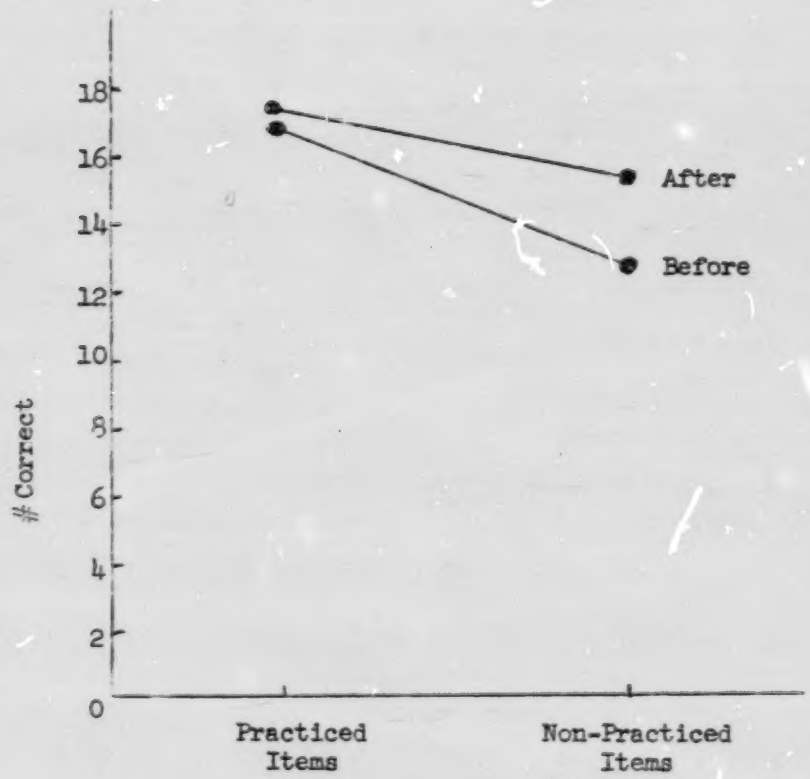

Figure 1. Interaction Between Adjunct Aid Position and Scales for Analysis Without Control Group

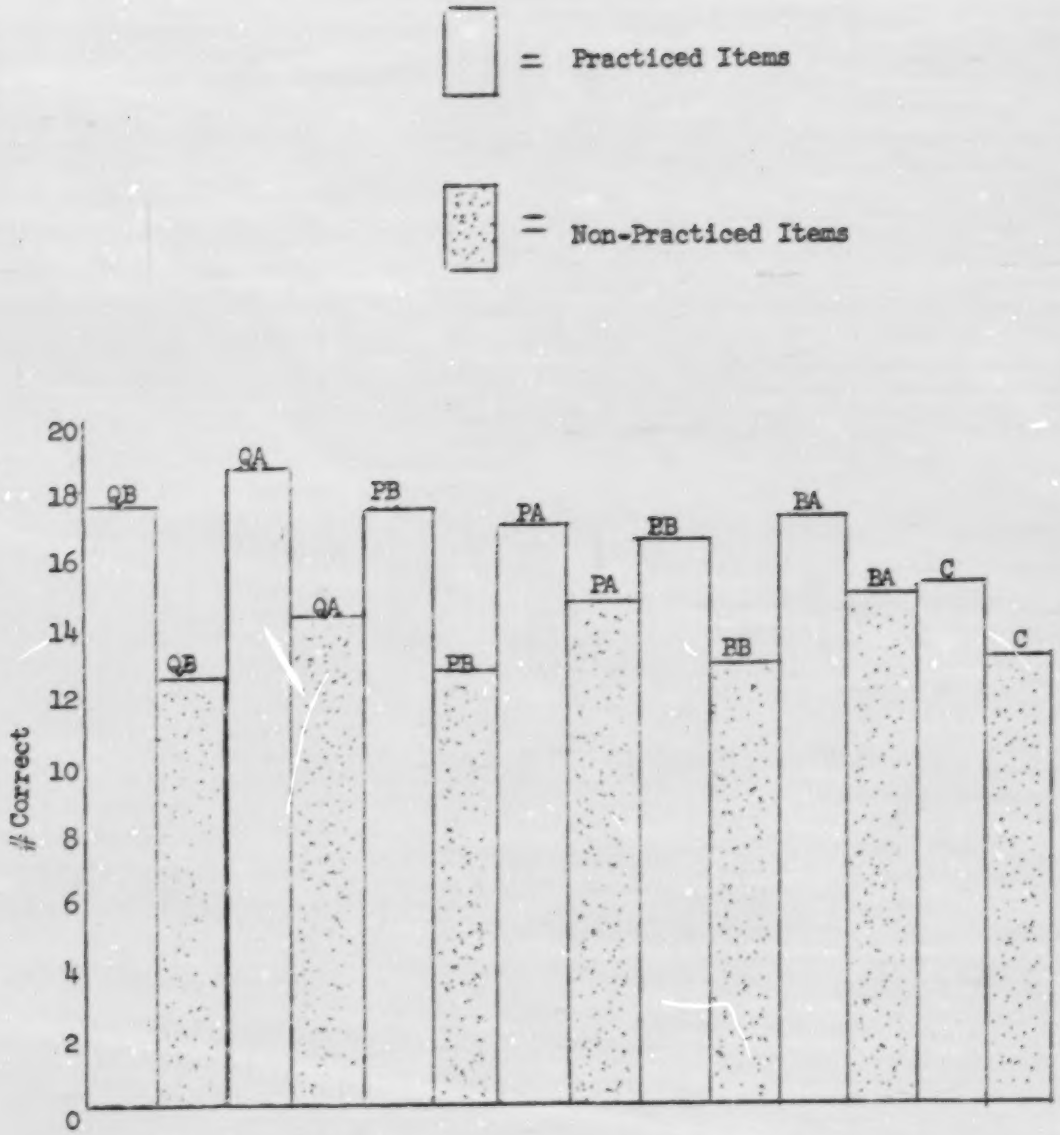

Figure 2. Interaction Between Type of Adjunct Aid and Scales for Analysis with Control Group

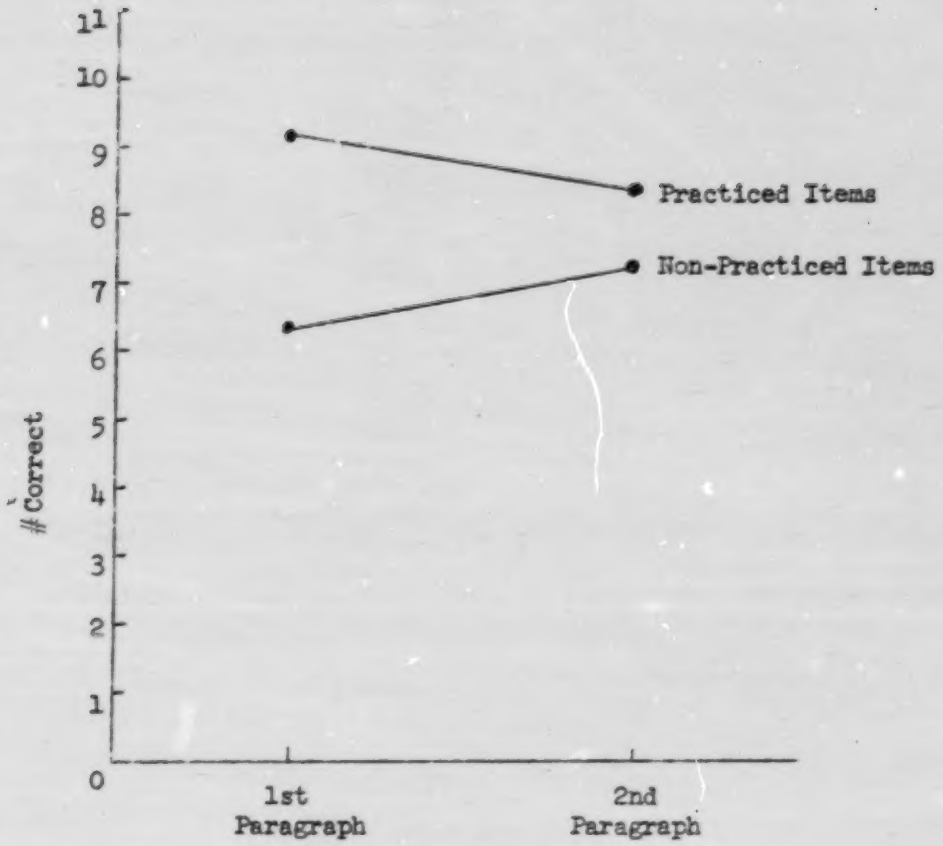

Figure 3. Scales x Paragraph Location Interaction

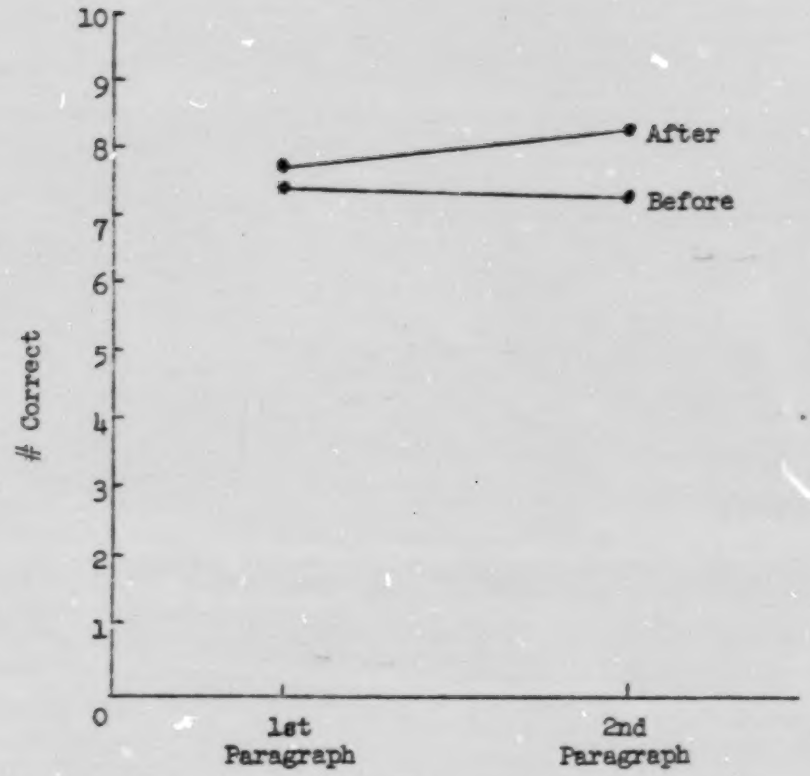

Figure 4. Position of Adjunct Aid x Paragraph Location Interaction

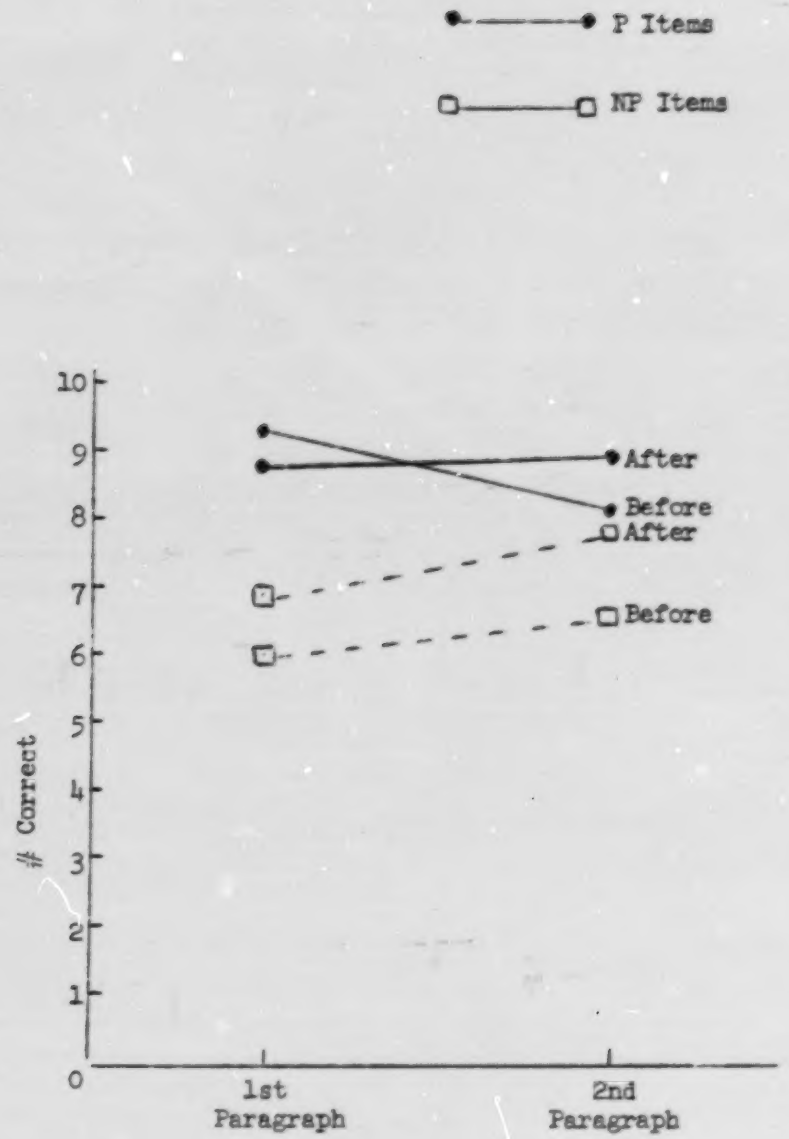

Figure 5. Position of Adjunct Aid x Paragraph Location Interaction for Practiced and Non-Practiced Items

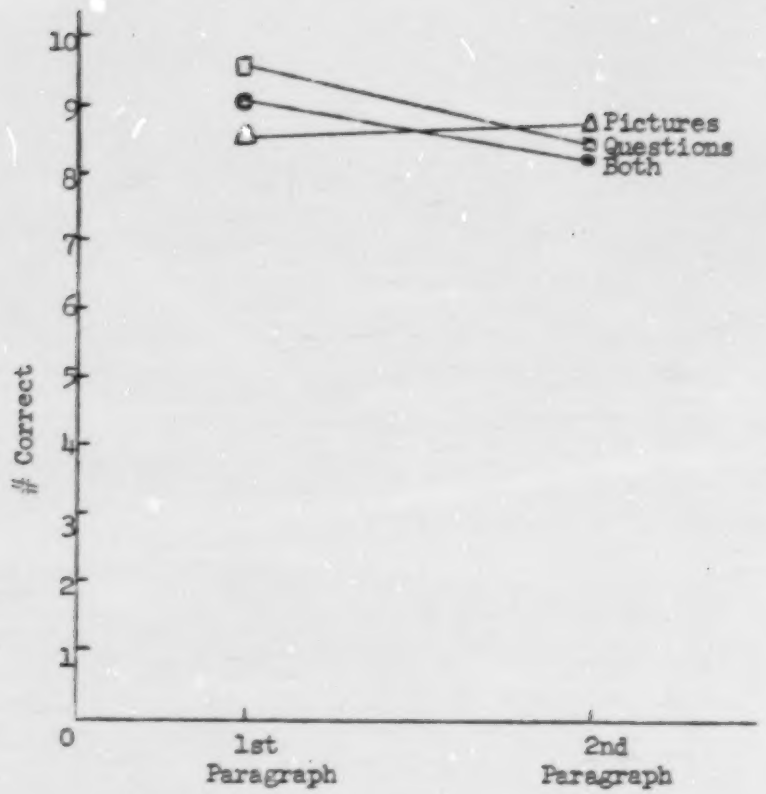

Figure 6. Type of Adjunct Aid x Paragraph Location Interaction for Practiced Items